RETINA SURGERY

Comparison of External Magnet and Intraocular Forceps for Intravitreal Foreign Body Extraction

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ABSTRACT

Purpose: To compare the adverse events after the use of 2 conventional methods of magnetic intravitreal foreign body (IVFB) extraction and to identify the prognostic factors in a series of patients with retained IVFB.
Design: Retrospective comparative interventional case series.
Participants: Seventy-one eyes of 71 patients with IVFB undergoing foreign body extraction.
Methods: A retrospective review was conducted on a consecutive series of patients undergoing vitrectomy, IVFB extraction, and other necessary vitreoretinal procedures. On the basis of the method of IVFB extraction, the eyes were categorized into 2 groups: group 1 (intraocular forceps extraction of IVFB [n = 30 eyes]) and group 2 (external magnet extraction of IVFB [n = 41 eyes]).
Main Outcome Measures: The rate of retinal break formation, the rate of development of retinal detachment (RD), and the change in visual acuity were observed. Univariate and multivariate analyses of a number of potential prognostic factors were undertaken.
Results: The overall rate of retinal break formation and development of RD was 41% and 7%, respectively. There was no significant difference between the 2 methods of IVFB extraction in relation to retinal break formation (group 1, 43%; group 2, 39%) and development of postoperative RD (group 1, 6.6%; group 2, 7.3%).

However, 3 cases of giant retinal dialysis occurred in group 1 ($P = 0.021$).

According to multivariate regression analysis, the factors predictive of poor visual outcome were the following: (1) longer duration between injury and FB extraction ($P = 0.006$), (2) lower preoperative visual acuity ($P = 0.02$), and (3) presence of afferent pupillary defect ($P = 0.043$).
Conclusions: The data from this study suggest no preference between external magnet and intraocular forceps for the extraction of magnetic IVFB. However, the use of external magnet for the extraction of IVFB may offer several advantages, including easier surgical handling and, as a result of decreased intraocular manipulation, the lower rate of giant retinal dialysis formation.

INTRODUCTION

Ocular trauma caused by intraocular foreign body (IOFB) is one of the major reasons for visual impairment. Approximately 40% of eyes involving open globe injuries harbor at least 1 IOFB.[1–4] Acute and long-standing visual loss associated with IOFBs usually affects children and young adults.[5] Metallic foreign bodies (FBs) are present in 75% to 90% of eyes containing IOFBs, and 55% to 80% of all those are magnetic.[4,6–9]

Therefore, magnetic foreign bodies are more common than nonmagnetic objects. The prevalent IOFBs, iron and copper, are reactive for the eye and have the potential to cause extensive damage if they are not removed promptly.[1,10] Foreign bodies can cause severe secondary infections also.

IOFBs may be located in anterior segment, ciliary body, lens, vitreous cavity, retina, and subretinal and retrobulbar space.[4,11–16] The final location of the IOFB was intravitreal in 47% to 61% of the eyes in different reports.[4,7,8,15] It is critical to carefully localize an IOFB before extraction because management is highly dependent on IOFB location.

In general, the extraction of IOFBs occurs through a sclerotomy incision at the pars plana or via the limbus with 3 introduced methods: intraocular forceps, internal magnet, and external magnet.[1,16,17]

It is opined by some investigators that magnetic extraction of IOFBs may be associated with better

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anatomical and functional results. However, it has not been documented.[1,18,19]

Complications of FB extraction include lens and retinal damage, traction on the retina or vitreous base causing breaks or tears in the retina, vitreous hemorrhage, and bleeding on the edges of the sclerotomy. One of the most serious complications of IOFB removal is retinal break formation at the site of sclerotomy resulting from the manipulation of the vitreous base, thereby causing retinal detachment and posttraumatic proliferative vitreoretinopathy (PVR) formation.[1,17,20]

To our knowledge, there has been no study focusing on the specific complications of intravitreal FB extraction by the use of forceps versus the use of external magnet.

Therefore, this study was conducted to compare the outcome and complications of 2 popular methods of intravitreal foreign body (IVFB) extraction: external magnet and intraocular forceps.

■ MATERIALS AND METHODS

We retrospectively studied the records of 417 patients referred to the Labbafinejad Medical Center for ocular trauma associated with IOFBs between 1986 and 2000. Of the 417 patients, 110 cases (26.37%) had a history of IVFBs. Of these 110 cases, 74 cases (67.27%) had magnetic intravitreal foreign bodies, 12 cases (10.90%) with metallic nonmagnetic FBs, 5 cases (4.54%) with glass FBs, and 1 case (0.90%) with stone FB; in 18 cases (16.36%), the nature of intravitreal FB was undetermined. Of the 74 eyes of patients with magnetic intravitreal FB who are the subjects of our study, 2 cases involving large intravitreal FB (size, >5 mm) were also excluded from the study. One other case of FB removal performed by the use of intraocular magnet was also excluded from the study.

We divided the remaining 71 cases into 2 groups on the basis of the FB extraction method: group 1 consisted of 30 patients (42.25%) who had FB extraction with the use of intraocular forceps; group 2 consisted of 41 patients (57.75%) who had FB extraction by the use of an external magnet. Therefore, the overall inclusion criteria consisted of eyes with single magnetic intravitreal FB of less than 5 mm in size.

All patients had a complete ophthalmologic examination including best corrected visual acuity (VA) measurement, afferent pupillary defect determination, biomicroscopic examination of anterior and posterior segment, intraocular pressure measurement, and indirect ophthalmoscopic fundus examination. In cases involving opaque media due to severe lens opacity or vitreous hemorrhage, a high-resolution computed tomography of the orbit and an ocular echography were performed. In cases involving overt siderosis bulbi, preoperative and postoperative electroretinography (ERG) was also performed.

The patients were followed up postoperatively for 6 to 76 months (mean ± SD, 29.69 ± 20.28 months). The best corrected VA, the presence of afferent pupillary defect, and the biomicroscopic and fundus examination findings were recorded at each follow-up visit.

Surgical Techniques

All eyes underwent 3-port pars plana vitrectomy. Pars plana lensectomy or extracapsular cataract extraction was performed in eyes with clinically significant lens opacity. Posterior chamber intraocular lens (IOL) implantation was performed in some cases when the posterior capsule was intact or when the posterior capsule remnants were enough to support a secure posterior chamber IOL implantation.

During vitrectomy, special attention was given to the removal of condensed vitreous and fibrotic tissue surrounding the FB. Then, the superotemporal sclerotomy site was adequately enlarged. Care was taken to enlarge the pars plana as much as the sclera.

On patients in whom intraocular forceps were used for IVFB extraction, the FB was grasped with suitable 20-gauge forceps and then extracted from the globe. An attempt was made to avoid damage to the lens in phakic patients. In those who underwent external magnet extraction of IVFB, the tip of an electromagnet was placed at the sclerotomy incision; then, the IVFB was extracted from the eye by the use of magnetic force. Regardless of which method was chosen for IVFB extraction, vitrectomy was repeated at the end of the procedure to remove any residual membrane or fine particles of the IVFB and its capsule, which might have dispersed. Indirect ophthalmoscopy examination aided by scleral depression was performed; then, any iatrogenic breaks in the periphery were treated by means of either cryopexy or laser photocoagulation if possible. If an open break was present, it was closed by means of placement of a segmental buckle, fluid-gas exchange, or both. An encircling prophylactic buckle (silicon band no. 240) was placed anterior to the equator in all eyes (Figs. 1–3).

Statistical Methods

All patients' data were entered into computer data sets; then, a summarization of χ^2 test and logistic multiple regression analysis was conducted using statistical system programs and procedures. All independent variables were recorded as values on ordinal scales to conduct the logistic multiple regression

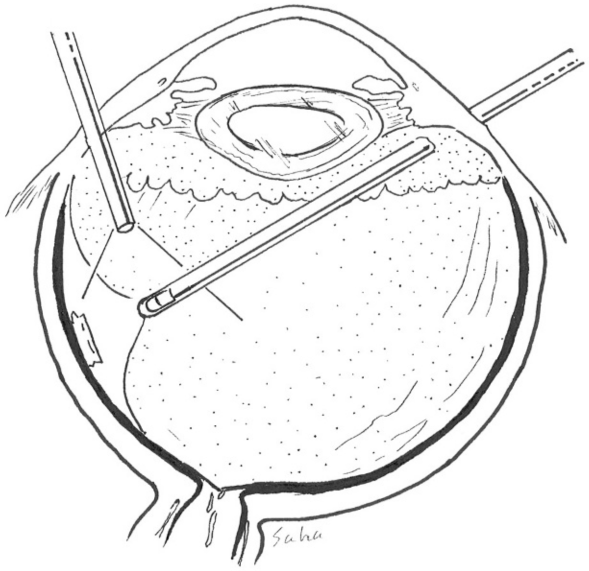

FIGURE 1. Figure showing deep vitrectomy to release vitreous attachments of IOFB.

analysis. The χ^2 test was also used to determine which factors were associated with either a good or a poor final outcome. The dependent variables were postoperative VA, retinal break formation, and retinal detachment.

The independent variables were preoperative VA, presence of afferent pupillary defect, intraocular pressure, site of entrance, FB size, method of FB extraction, elapsed time before extraction, and presence of vitreous hemorrhage.

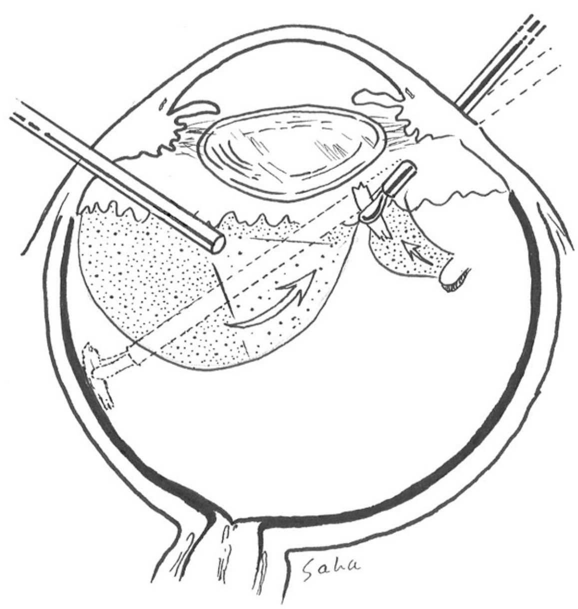

FIGURE 2. Figure showing the extraction of IOFB with forceps and the inducing of iatrogenic retinal tear.

■ RESULTS

General Characteristics

All of the 71 patients were men. Their age ranged from 8 to 77 years (mean ± SD, 27.59 ± 12.34 years). Twenty-six cases (36.6%) involved the right eye and 45 cases (63.4%) involved the left eye.

Ophthalmologic examination disclosed that an afferent pupillary defect was present in 10 cases (14.1%), whereas it was absent in 61 cases (85.9%).

The site of entrance of the IVFB was the cornea in 43 cases (60.6%), sclera in 22 cases (31%), and cornea-sclera in 6 cases (8.4%).

There was a history of primary laceration repair in 55 cases (77.46%).

During the initial fundus examination of patients, severe vitreous hemorrhage was detected in 12 cases (16.90%).

The FB size in 35 cases (49.30%) was between 1 and 2 mm; in 24 cases (33.80%), between 2.5 and 3.5 mm; and in 12 cases (16.90%), between 4 and 5 mm (Table 1). In 37 eyes (52.11%), lensectomy or extracapsular cataract extraction was performed during surgery; in 34 eyes, the lens was spared. A posterior chamber IOL was implanted in 10 eyes (14%) during the procedure. Siderosis bulbi was present in 6 eyes (8.5%). Follow-up ERG after surgery revealed no progression of siderosis in these cases, although no reversal of ERG change was observed either.

Visual Result

Preoperatively, the VA was less than 20/200 in 35 eyes (49.3%), and 7 eyes (9.9%) had VA of *light perception* or *hand motion*. In 36 eyes (50.6%), the initial VA was 20/200 or better (Tables 2, 3).

FIGURE 3. Figure showing the extraction of IOFB with external magnet and the inducing of iatrogenic retinal tear.

TABLE 1. *Summary of Important Clinical Characteristics of Patients With Magnetic IVFB Undergoing Foreign Body Extraction by Means of Either Intraocular Forceps or External Magnet*

Clinical findings	*No. cases using intraocular forceps*	*No. cases using external magnet*
Afferent pupillary defect	7	3
Vitreous hemorrhage	4	8
Mean age (y)	29.21	25.3
Foreign body size (mm)		
1–2	20	15
2.5–3.5	8	16
4–5	2	10
Posttraumatic endophthalmitis	3	4
Lens extraction	17	20
IOL implantation	3	7
Break formation at superotemporal sclerotomy (site of IVFB extraction)	13	16
Break formation at superonasal sclerotomy	5	3
Retinal detachment	2	3
Giant retinal dialysis	3	0
Break formation in patients who underwent lens extraction	5	7
Break formation in phakic group	8	9

Postoperatively, 49 eyes (69.01%) attained a VA of 20/200 or better, and 2 eyes (2.8%) had a VA of *light perception* or *hand motion* (Tables 2,3).

According to logistic multiple regression analysis, the predictive factors of good outcome (VA > 20/200), in order of importance, were the following:

1) shorter interval between trauma and IVFB removal (P = 0.006);
2) initial VA of 20/200 or better (P = 0.02); and
3) absence of APD (P = 0.043).

Retinal Break Formation

In group 1 (method, intraocular forceps), retinal break was observed at the time of surgery in 15 cases (50%); in 3 cases (4.22%), retinal break was detected during the first 2 weeks after the operation. The location of the breaks in 13 cases (43.33%) was posterior to the superotemporal sclerotomy incision, and 3 of them developed giant retinal dialysis after IVFB extraction. Five breaks were detected posterior to the superonasal sclerotomy incision. In 4 cases, the breaks were posterior to both the superotemporal and the superonasal sclerotomy incisions.

In group 2 (method, external magnet), retinal break formation was observed at the time of surgery in 15 cases (36.58%); in 4 cases (5.63%), retinal break was found during the first 2 weeks after the operation. The location of the breaks was posterior to the superotemporal sclerotomy incision in 16 cases (39.02%) and in 3 breaks was also posterior to the superonasal sclerotomy incision. No case of giant retinal dialysis was detected. A cryotherapy of intraoperative retinal breaks was performed in all cases when a retinal break was found in the periphery of the retina.

Retinal Detachment

Overall, in 5 cases (7.04%), early retinal detachment (within 2 weeks after surgery) occurred: 2 in group 1 (forceps extraction) and 3 in group 2 (external magnet extraction).

There was no significant difference between the 2 groups in retinal detachment development. When the development of retinal detachment was used as an outcome, according to the logistic multiple regression method, no single independent factor could predict the outcome. In 2 cases, retinal reattachment was achieved by means of additional vitreoretinal surgery; finally, 3 cases ended in visually lost eye because of severe PVR formation.

Elapsed Time Before FB Extraction

Because of late referral, the surgical procedure was usually performed more than 2 weeks after the initial injury in 57 cases (80.28%).

All of the eyes were divided into the following groups according to the elapsed time between the injury and the IOFB extraction: less than 2 weeks (14 eyes [19.7%]); between 2 and 4 weeks (28 eyes [39.4%]); between 1 and 6 months (19 eyes [26.8%]); between 6 and 12 months (6 eyes [8.5%]); and more than 1 year (4 eyes [5.6%]). Most FB extraction was performed between 2 and 4 weeks after the penetrating ocular trauma. The multiple regression analysis showed statistically significant association between the time of IOFB extraction and the final visual outcome (P = 0.006). This means that the eyes that underwent IVFB extraction within 4 weeks of initial injury had significantly better visual outcome than those that underwent surgery after more than 4 weeks.

Development of Endophthalmitis

In 7 cases (9.85%), a diagnosis of acute posttraumatic bacterial endophthalmitis was made. Three cases had been detected in group 1 (intraocular forceps) and 4

TABLE 2. *Visual Acuity Before and After Surgical Procedure*

Visual acuity	*Initial, n (%)*	*Final, n (%)*
Light perception/ Hand motion	7 (9.9)	2 (2.8)
<20/200	28 (39.4)	20 (28.16)
20/200–20/120	10 (14)	13 (18.3)
20/80–20/50	9 (15.5)	15 (21.12)
>2/40	17 (23.9)	21 (29.57)

TABLE 3. *Comparison of Postoperative Visual Acuity Based on the Method of IVFB Extraction*

Method of IVFB extraction	*Better, n (%)*	*Same, n (%)*	*Worse, n (%)*
Intraocular forceps	14 (46.67)	6 (10)	8 (26.66)
External magnet	26 (63.41)	8 (19.51)	7 (17.07)

cases in group 2 (external magnet). In 4 cases, the IOFB was extracted before 2 weeks; in 3 cases, the FB was extracted after 2 weeks. In all, 3 cases of endophthalmitis wherein the IOFB had been extracted after 2 weeks all finally ended to lost eye.

■ DISCUSSION

Ocular trauma with IOFB caused significant visual impairment; most eyes involving open globe injuries have at least 1 IOFB.[1–4] Metallic-magnetic IOFBs are more common than other objects, and we had shown previously that up to 61.9% of all IOFBs were magnetic in our series.[4] It is important to know that the final location of the IOFBs is intravitreal in 47% to 61% of the cases.[4,7,8,13–15] The results of vitreous surgery for magnetic and nonmagnetic IOFB extraction are remarkably good and indicate that a final VA of 5/200 or better can be obtained in at least two thirds of the eyes.[16,21–23] Two popular surgical methods of IOFB extraction include the use of intraocular forceps and external magnet. To the best of our knowledge, there is no literature comparing the 2 methods in terms of complications. Therefore, it has remained a matter of controversy as to which method is preferred. Many authors have advocated the use of magnets to lessen the chance of intraocular inflammation and trauma induced by the use of forceps,[24,25] whereas others advocate the use of forceps for more controlled removal of IOFBs.[16]

The surgical complications of IOFB extraction includes retinal break formation posterior to sclerotomy, disrupted lens, tractional retinal detachment, and damaged vitreous that stimulate and provide the scaffold for fibrocellular ingrowth.[1,16,26]

Our study was designed to compare retrospectively the outcome and the complications of the 2 mentioned methods of IOFB extraction in cases involving IVFB during vitreous surgery. Table 4 provides a comparison of the 2 methods of IOFB removal.

The data from this study showed that the rate of retinal break formation in cases of IVFB extraction using forceps and using external magnet was 43% and 39%, respectively. Likewise, the rate of early postoperative retinal detachment in our study was 6.6% and 7.3%, respectively.

The iatrogenic peripheral retinal breaks have been reported as the most common serious intraoperative complication of pars plana vitrectomy in general.[27] Its prevalence rate has been reported to be between 6% and 11% and is highly dependent on the underlying disorder.[27] The rate of occurrence has been reported to be higher (22%) during vitrectomy for proliferative diabetic retinopathy complication; the lowest rate of incidence has been reported in cases of vitreous surgery for epiretinal membrane removal.[27]

The mechanism proposed as the cause of the development of these iatrogenic peripheral breaks is instrument insertion that may cause traction on the adjacent vitreous, causing a retinal tear along the posterior border of the vitreous base. Alternatively, the vitreous may be incarcerated in the sclerotomy site during the withdrawal of an instrument, causing traction and retinal break along the posterior border of the vitreous base.

Despite the improvements in instrumentation and surgical techniques, iatrogenic peripheral retinal break continues to be an important complication of pars plana vitrectomy. Peripheral retinal breaks are correlated with multiple passage and interchange of instrument through the sclerotomy. As expected, IOFB extraction is associated with more interchange of instruments such as forceps and, as a result, more manipulation of the vitreous base; thus, the rate of this complication should be even higher in the forceps group. However, in contrast to our initial impression, our study disclosed, the rate of retinal break formation posterior to the

TABLE 4. *Comparison of External Magnet and Intraocular Forceps for IOFB Extraction*

	External magnet	*Intraocular forceps*
Nature of IOFB	Only useful for magnetic IOFBs	Capable of removing any IOFBs
Size of IOFB	More suitable for small IOFBs	Capable of removing any IOFBs
Surgical handling of IOFB		
Intraocular trauma	Less	More
Manipulation of vitreous base	Less	More
Controlled removal	Less	More
Iatrogenic retinal breaks	Equal (controversial)	Equal (controversial)
Iatrogenic retinal detachment	Equal (controversial)	Equal (controversial)
Giant retinal tear	Less	More
Postoperative inflammation	Less	More

sclerotomy was almost equal (39% vs 43%) in both the magnet and the forceps groups. This indicated that the passage of FB through the vitreous base, independent of the method of extraction, may have the greatest impact in the formation of these kinds of breaks.

The comparison of the rate of retinal break formation posterior to sclerotomy incision between the superotemporal sclerotomy that was enlarged for IOFB extraction and the superonasal sclerotomy that was subject to less manipulation indicated that the chance of break formation posterior to superotemporal sclerotomy was 2.7 times more than that of break formation posterior to superonasal sclerotomy in the forceps group (43% vs 16.6%, respectively). Similarly, in the magnet group, the retinal break formation posterior to superotemporal sclerotomy was 5.1 times more common than that of break formation posterior to the superonasal sclerotomy (39% vs 7.6%, respectively).

An explanation for the higher rate of giant retinal dialysis formation in forceps group can be the enlargement of sclerotomy incision, in addition to more vitreous base manipulation for the retrieval of IVFB. The distance of sclerotomy incision from the limbus did not show any effect on retinal break formation between phakic and aphakic eyes in this study.

Early detection of these iatrogenic peripheral breaks immediately after IOFB extraction and proper treatment are critical to prevent subsequent retinal detachment and PVR formation.

Our study disclosed that a VA of 20/200 or better could be attained in 69% of cases, whereas approximately 30% of these cases achieved a VA of 20/40 or better. There was no difference between the 2 methods, forceps and external magnet IVF extraction, with regard to final VA. By using multivariate analysis, we found that the short interval between trauma and IVFB extraction was the most important predictive factor of good visual outcome. This is similar to the findings in other published reports[11,24] and suggests that for possible prevention of acute posttraumatic endophthalmitis, the timing of surgery is one of the most important factors that affect the outcome and can be partially influenced by the surgeon. Early IOFB removal can also prevent the formation of siderosis bulbi.

In our study, preoperative VA was the second most significant predictor of visual outcome. Similar to other studies, the prognosis was poorer in patients with lower initial VA.[4,20,28] The presence of APD was the third predictor of poor prognosis in our series, thus confirming the role of APD as a helpful measure of optic nerve dysfunction and mass retinal response.[4,20,28–31]

In summary, our study disclosed that the anatomical and ocular functional results of IVFB extraction were independent of the 2 applied methods of FB extraction.

However, practically, our experience has shown that the use of external magnet may offer the surgeon an easier surgical handling. In addition, theoretically, the use of external magnet may provide several other advantages: less intraocular maneuver and vitreous base manipulation, minimization of intraocular inflammation, less damage to lens in phakic eyes, less need for interchange and passage of instrument, and, as a result, a lower rate of giant retinal dialysis formation.

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